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PATENT APPLICATION OF

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FOR

RAIL WELDERHEAD SHEAR APPARATUS

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

RAIL WELDERHEAD SHEAR APPARATUS

Claim of Priority

Priority is claimed based on our Provisional patent application Serial No. 60/226,232 filed August 18, 2000 and entitled "RAIL WELDERHEAD SHEAR APPARATUS."

Background of the Invention

Field of the Invention

An improved rail welderhead using extremely structurally strong quadrants, having large sections to yield high strength and the application of much larger forces in the single unit. This enables the single unit to perform tasks previously requiring separate pullers and forging-force welderheads. Because both rail stretching and tensioning and forging is done by the welderhead, it therefor becomes important to maintain tension while the weld cools. It is also desirable to shear the flash while the weld has not cooled substantially. Accordingly it is necessary to have a shear die set actuated using a high strength but compact mechanism requiring minimal clearance and operation within the area contained by the quadrants.

In this manner a single welderhead can be used for multiple purposes including pulling or stretching rail strings to flash butt forging while under tension and shear die operation without releasing rail tension and forging load.

Description of Related Art

In the prior art flash butt welderheads clamp rails to provide electrical contact, heating cycle movement and forging force using quadrants. Rail stretching generally requires a separate mechanism with a frame, and clamps to apply a stretching force. The stretching mechanism is left loaded as a weld is completed, one opposite pair of welderhead quadrants released to provide

clearance, and a separate shear die used to remove the flash from the weld.

The invention enables the shearing operation within the perimeter of a fully clamped, high force welderhead that eliminates the need for the separate stretching mechanism and improves the efficiency and quality of the welds by eliminating the need to open an opposite pair of quadrants to accomplish shearing.

Railroad rails are welded using a number of different methods. One superior method in terms of weld quality is known as flash butt welding. Flash butt welding originally was developed many years ago, and has been refined over the years. Of recent significance has been the addition of the rail stretching or pulling procedure, which has heretofore been unable to be performed by the welderhead alone, in part due to the high force and concomitant strength and size requirements.

Brief Description of the Preferred Embodiment

The welderhead uses a lever actuated shear die placed proximate the firebox of the welderhead. Unlike prior shear die mechanism actuators, the instant actuator enables the use of extremely strong arms on the welderhead and related structure and hydraulics that will enable the pulling of the rails themselves as well as the forging or upsetting operation. The improved shear die mechanism enables the jaws to remain fully clamped while the shear operation is accomplished. Thus, improved clearance and strength enable the elimination of many of the separate steps necessary for the combination of rail pulling, forging and shearing thereby enabling the performance of these functions smoothly and continually.

In accordance with one aspect of the present invention, a rail welderhead comprises two opposing pairs of quadrants constructed and arranged to close on adjacent rail sections and provide rail clamping by engagement of pads provided on the rail sections, the opposing pairs of quadrants defining a firebox therebetween, and a shear die fully enclosed within the firebox

such that, when the welderhead's opposing quadrants are in a fully closed position, the shear die, the fully sheared weld, and the weld collar are contained within the firebox.

In one form, the shear die set is actuated through push rod and shaft assemblies. The adjacent rail sections may be welded by flash butt rail welding. The opposing pairs of quadrants are operative to pull and stretch the adjacent rail sections. Preferably, the opposing pairs of quadrants are operative to provide forging load for the adjacent rail sections, and shear die operation is performed without releasing rail tension and forging load.

Further objects, features, and advantages of the present invention will become apparent from the following description and drawings.

Brief Description of the Drawings

Fig. 1 is an exploded perspective view of the shear die actuating mechanism.

Fig. 2 is a front elevational view of the rail welderhead with the shear die actuating mechanism.

Fig. 3 is a side elevational view of the shear die actuating mechanism.

Fig. 4 is a side elevational view of the exploded shear die actuating mechanism.

Fig. 5 is a front elevational view of the shear die.

Fig. 6 is a flow chart.

Detailed Description of the Preferred Embodiment

A flash butt rail welding welderhead 10 uses paired quadrants 12, 14 to capture ends of rails 16. A shear die set 18 is formed to correspond to the section of the cold rail 16. The shear die set 18 is put in place and actuated through push rod and shaft assemblies 20, themselves coupled to levers 22 enabling clearance in a welderhead 10 using extremely structurally strong quadrants, 12, 14, that have large sections to enable high strength and much larger forces. In this manner a single welderhead 10 can be used for multiple purposes including pulling or stretching

rail strings to flash butt forging while under tension and shear die operation without releasing rail tension and forging load.

The welderhead 10 has four quadrants, as is known in the art. For clarity, only the right front quadrant 12 is shown in Fig. 1, 3, 5. Fig. 2 shows a pair of quadrants 12, 14. One of ordinary skill will understand the generally symmetric arrangement of the pivotally and slidably interconnected four quadrants. Quadrant 12 has trunnion 30 formed in boss 32 and arm 34 extending downward therefrom. Arm 34 holds clamping pad and electrode 36 which engages rail 16 with corresponding pad and electrode clamp rail 38 therebetween. This welderhead arrangement enables a rail pulling and stretching capacity of 150 to 200 tons. The welderhead can also have a pushing or forging capacity.

Important in meeting these functional goals is the inclusion of an internal shearing mechanism 40 and shear die set 18 which provide a way of shearing while maintaining hold of the pads 36, 38 on the welded rail sections. The internal shearing mechanism 40 can be used with welding machines of various pulling capacities. A prior art standard 130 ton welder head does not necessarily have the pulling capacity to stretch long strings of rails and also requires a separate mechanism to maintain a forged position while a quadrant is released to provide clearance for a prior art external shear die mechanism. A 150 Ton Puller / Welder Combo is enabled by the combination of elements taught in this application.

A shear die set 18, its section corresponding to the section of the cold rail 16, is fit loosely on the cold rail 16. In the invention, the shear die set is put in place and actuated through push rods. In this manner a single welderhead can be used for multiple purposes including pulling or stretching rail strings to flash butt forging while under tension and shear die operation without releasing rail tension and forging load.

In particular, the shear die assembly 40 uses lever 22 which is supported on stay assembly 42 and reaction rod 44 against which the compressive force of shearing is borne. Various fasteners 46 will be known to one of ordinary skill. The shearing force is exerted by cylinder 50 acting through pin and clevis 52 attached to lever 22.

The cylinder 50 is mounted with trunnion mount assembly 54 to trunnion 30. Reaction rod 44 is mounted to arm 34. In this manner, lever is adapted to move relative to quadrants 12, 14, it being understood that a shear die assembly 40 will be mounted on each front quadrant 12, 14.

Carried apertures 56 in arm 34 are shear die pushrod assemblies 58. These are pushed by plate assemblies 60, 62 on which lever 22 bears through fasteners 46, bearings or bushings 64 and pins 66.

The welderhead 10 will weld a rail, pull the rail, shear the welded rail, and hold the welded rail until the weld cools adequately. It may be contained as a single unit and suspended from a single point (cable). The welderhead 10 is formed and arranged so that no part of the welderhead 10 will extend below the bottom surface of the rail base, except for the shear tooling. The welderhead 10 will be shielded from damage which may be caused by the welding process from weld initiation through rail shearing. Despite its high capacity, the welderhead 10 will, when fully closed for storage, fit within an envelope of 7' long x 4' wide x 4' high. The weight of the welderhead 10 when fully operational will be such that it can be carried in an over-the-road truck or van (not shown) that, when fully fueled and operational will be road legal without permits in all 50 states. Only one man will be necessary to operate the equipment. The welderhead 10 will be able to make welds in low, maintenance and high stress applications.

In Fig. 5, the shear die set has a pair of brackets, pivotally connected, and a pair of replaceable die members. These are fitted as described above and actuated with the mechanism also described.

The welderhead 10 of the design and having the features taught herein is capable of producing about 20 non-stressed welds per hour in-track. This includes Positioning and Placement of the welderhead 10, clamping to the rail, completing a 7-5" rail pull, aligning to specification, preheating, flashing, forging and shearing the weld-release of the rail and removal from the rail.

The welderhead 10 taught herein has a weld cycle time from weld initiation until completion of shearing for 136 lb. /yd. rail of about two (2) minutes or less. The welderhead may be expected to produce 50,000 welds between major overhauls.

The general standards for rail welding, including rail sizes and sections, specifications for Steel Rails, Fabrication of Continuous Welded Rail and rail metallurgies are set forth in the 1996 issue of publications of A.R.E.A. (American Railway Engineering Association). This organization has since merged with other engineering support organizations to form AREMA; the American Railway Engineering and Maintenance-of-Way Association. Specifically, the publications 1996 A.R.E.A. design of Recommended Rail Sections; 1996 A.R.E.A. specifications for Steel Rails; 1983 A.R.E.A. specification for Fabrication of Continuous Welded Rail; 1996 A.R.E.A. Standard for Rail metallurgies to be welded; 1996 A.R.E.A. High-Strength Grade designations; and 1986 Grades 700, 900A, 900B and 1100 are incorporated by reference as if fully set forth herein. Rail welds produced by the welderhead 10 will comply with the latest issue of the A.R.E.A. specification for Fabrication of Continuous Welded Rail except for section 2.2.2.b.(2); the first two sentences, 'Horizontal alignment ... Field side.'

In operation, two opposite pairs of quadrants will close on rail providing rail clamping by engagement of pads on rail. Clamping force is imparted and clamping pressure maintained by cylinders. The rail clamping forces will be sufficient to avoid any slippage between the welderhead 10 and the rail. Trunnions slide longitudinally on shaft their motion being imparted by cylinders . With this mechanism, the welderhead 10 will be able to reverse its direction of operation and accomplish its full range of rail pulling (200 tons) and pushing (40 tons) without loosening its clamp seat or changing the weld alignment.

The arrangement of arms and clamping electrode enable welderhead 10 to clamp and weld rails which are 3.5 feet in length or longer. The relationship between the electrode clamping force, the electrode contact area and the maximum welding current is such that no adverse metallurgical (martensite) or surface (metal displacement) conditions occur at any time during the weld process and also such that the electrodes do not plastically deform (mushroom).

The material, size, surface and clamping force applied through electrode are formed and arranged such that contact with the rail does not produce any vertical surface deformations deeper than 0.040 inch and with a root radius less than 0.062 inch and does not form any horizontal deformations. Any surface deformations that do form will, in any event, not be within the Heat Affected Zone (HAZ) produced during welding. The precise level of control of clamping, utilizing controls, valves and hydraulic hoses and fitting is also such that "soft clamping" of the rails can be accomplished to facilitate alignment.

A major advantage of the welderhead 10 of the invention is the ability to combine in a single unit, the ability for the three functions of rail pulling, flash butt forging and maintaining the "after forged" displacement without any change in platen position. The horizontal plane of force of the rail pull will have a mechanized adjustment to approximately match the neutral axis of all rail sizes specified. The welderhead 10 has a rail pulling (together) ability of 200 tons. The

the welderhead 10 in place on the rail. Horizontal alignment of the rail in the welderhead 10 shall be done on the web of the rail. In curved territory, initial horizontal alignment will be achieved with gauge bars.

Once weld alignment has been established by the welderhead 10 and the weld process initiated, the established weld alignment will not change throughout the weld process completion and until the induced stressing force, if any, is completed. The welderhead 10 will make the final horizontal and vertical adjustment and not allow a horizontal or vertical offset to occur during forging. The ability to maintain clamping pressure throughout the process, including the shearing operation, not only insures the maintenance of proper alignment, but also minimizes such stresses as may be induced in a cooling weld by the release of a quadrant pair for the shearing operation.

The welderhead 10 will be electrically insulated to prevent any welding current flow by-passing the weld. Welding electrodes and transformers will be situated to ensure that the secondary current loop is minimized. The welding electrodes will be adjustable to accommodate the various rail sizes specified. Electrodes can be a single alloy, a composite of two or more elements or laminated materials.

The welding of rails which have been previously drilled for installation of rail joints or to facilitate handling must be considered with respect to welding current transfer. Rail drilling-patterns to be accommodated are as shown in the latest issue (1995) of the A. R. E. A. design of Recommended Rail Sections. Six hole bars with the four outside holes drilled will have required current transfer parameters calculated by the control system.

As described above, weld shearing is an essential step in the production of a suitable, finished welded rail. On new rail, forged material needs to be sheared to within 0. 125 - of the parent rail contour. In this invention, the shearing process will be accomplished without

upsetting force for refusal will be selectable from 36 to 72 tons in increments of at most one ton regardless of any rail drag or stressing forces. Upsetting force, when welding to refusal, will not vary by more than one ton.

The total range for upset distances will be in selected increments and upsetting distance when welding to fixed distance, will not vary outside acceptable tolerances.

The control system will control rail ends to prevent interruptions in flow of current and shorting (extinguishing of the arc) for 3 cycles or greater at any time during preheating, flashing or accelerated flashing. The variables in the above functions will be manually controllable from the programming control station. The control will limit the ability of the welderhead 10 to reverse beyond the point of the original set up position, minimize total rail consumption and minimize machine over capacity.

Transducers will measure Welding current, Welding platen position and Pulling/Upsetting force. Reporting progress and performance can be preferable included on performance factors such as slippage detection during forging between the rail pulling clamps and the rail, track spring rate and total rail consumption. Monitoring these can signal a go/no go decision. Upon completion each weld can have reported secondary current interruptions, upsetting (forging) distance, force and cooling hold time and then compared to standards.

The control system will also preferably monitor current flow, current (instantaneous) platen position (to determine stroke), current (instantaneous) force (to determine available force).

The operation will perform the following steps. First, the operator measures the rail gap and compares it to the acceptable range. Second, the operator lowers welderhead 10 to rail 16 using boom controls. Third, the operator places right hand side of welderhead 10 in welding position and clamps the welding machine a specific distance from the rail end.

Fourth, the welderhead itself will pull and stretch the rail until rail ends butt welderhead automatic stop. As part of this step, the machine may re-coil by relieving pressure to upset cylinders and then, determine gap, pull force and preferably provides information to enable a go/ no-go decision to the Weld Monitor. A no-go signal disables the welding function and gives an explanation of the reason to a Weld Monitor. The mechanical functions could be performed, albeit less effici4ently, without the automatic Weld Monitor function. Fifth, if necessary, the operator can release for vertical adjustment, then re-clamp and repeat step four several times.

Sixth, the welderhead 10 is started to move to the start weld position. The left hand side will release and reposition to allow proper stroke and, then re-clamp.

Seventh, the weld cycle is performed involving the sub-steps of (a) burn off, (b) preheat, (c) flashing, (d) acceleration flashing, (e) upsetting (forging & holding), (f) shear & retract and (g) post-heating.

Eighth, welderhead 10 holds rail under tension until sensor signals proper rail temperature has been reached and enables manual release.

Ninth, the operator activates manual release to automatically relax the rail pull force and unclamp the welderhead 10 from the rail.

Last, the operator raises welderhead 10 and moves to next weld.

The operator can interrupt and restart the weld program by stopping the cycle and opening the control contact and interrupting the weld program. Operator takes over manual operations. Any repositioning or delayed restart will cause the control to be restarted from beginning of the cycle. Otherwise, the cycle resumes from the point of stoppage. The operator can relax all hydraulic pressure and stop all electricity by shutting down the engine.

While the present invention has been disclosed and described with reference to a single embodiment thereof, it will be apparent that variations and modifications may be made therein.

It is also noted that the present invention is independent of the machine being controlled, and is not limited to the control of inserting machines. It is, thus, intended in the following claims to cover each variation and modification that falls within the true spirit and scope of the present invention.

What is claimed is: